Generation and residues management in timber industries in the Midwest region of the state of Paraná

Geração e gerenciamento de resíduos nas indústrias madeireiras na região centro-oeste do estado do Paraná

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ABSTRACT
The timber industries generate significant amounts of waste, throughout its production process, constituting an environmental aggravating, due to its inadequate final disposal and the lack of alternatives to use. This study aimed to diagnose the generation of solid waste and evaluate the management of these in the timber industries. Through the application of a questionnaire, a diagnosis was made of the main residues generated by sawmills, veneer and plywood industries in the regions of Guarapuava e Irati, Paraná, verifying the management of these residues and the environmental performance of the industries. An amount of 13 thousand m³/month of generated residues was diagnosed, with emphasis on “costline”, “wood processing finishing residues (dust, wood shavings)”, “log core” and “plywood cutting”. Only 50% of industries separate the residues, 11 make use of this residues and 9 have environmental management systems. It can be concluded that the industries lack alternatives for destination and use.

Keywords: use, final destination, byproducts, sawmills, veneer and plywood.

1 INTRODUCTION
Over the past few years, urbanization and industrialization has been expanding. As a result, according to Fonseca et al. (2018), the environment has undergone many negative changes. The demand for raw material increases and consequently the extraction of wood becomes an activity with a certain impact on the environment.

The impacts generated by the demand for raw materials consist of the high generation of waste from the different wood transformation processes. Data from the Brazilian Tree Industry (IBÁ) indicate that in 2018, the sector generated 52.0 million tons of solid waste, of which 36.9
million (70.9%) were generated by forestry activities and 15.1 million (29.1%) for industrial operations (IBA, 2019).

Forest-based industries, throughout their production processes and operational phases, regardless of the type of industry and the cutting process used, annually generate significant amounts of waste. These, if not properly used and/or disposed of, will accumulate in the respective industrial yards, causing numerous damages to the environment and also to the surrounding society (MENDOZA et al., 2020).

Given this scenario, knowing information about wood residues is of fundamental importance, not only for the government, which, for example, will be able to build public policies for environmental control and monitoring, but also for the private sector, because with this information decisions can be made about investments, products and markets, forms of management, disseminating this information to society in general, (BRASIL, 2012).

For these reasons, the practices of management, management, adequate packaging and final destination of the waste generated must be present in the midst of organizations. Thus, solid waste management is defined as a combination of the method of production, storage, collection, transfer, transport, processing and disposal of this waste, considering sanitary, economic, engineering, aesthetic and environmental aspects (AFRIZAL, 2016).

Some important behavior and incentive changes are already seen in this sector. According to IBÁ, the reuse of waste from production processes has increased and received important investments. In 2021, 63.6% of companies associated with IBÁ directed their industrial and forestry waste to power generation, a figure 6.4% higher than the previous year. Still, 17.2% of the producers keep the residues in the field to protect the soil against erosion, improve its ability to infiltrate rain and improve the nutritional quality of the soil, with 6.6% of the producers choosing other destinations, such as co-processing (IBÁ, 2022).

In this way, it is necessary to change the behavior not only of the consumer, but of society in general, demanded by the characteristics of greater demand in relation to the relations with the environment, making it necessary to change also in the posture of the companies and its society – environment interrelationship (COUTO and PEREIRA, 2018).

The present study aimed to verify the generation and evaluate the management of solid waste in the wood industries.
2 MATERIAL AND METHODS

2.1 SELECTION OF TIMBER INDUSTRIES

The first stage consisted of a previous contact with the syndicate of timber industries of Guarapuava and an electronic consultation for Irati, state of Paraná, in order to explain the objectives of the work and verify the interest of the industries to participate in the study.

In a second moment, were selected 12 industries with interest to collaborate and the contact was made to schedule visits to carry out the data.

2.2 DATA COLLECTION AND RESIDUES IDENTIFICATION

A diagnosis of waste generation was carried out in the sawmills, veneers and plywood industries, established in the municipalities of Irati-PR and Guarapuava-PR.

By means from visits to the industries and survey questionnaire, the wood waste generation was verified. Beyond the diagnosis of waste generation, a management of these residues and the environmental performance of these industries was verified.

2.3 ASSESSMENT OF SOLID RESIDUES MANAGEMENT AND ENVIRONMENTAL PERFORMANCE OF TIMBER INDUSTRIES

The evaluation of solid residues management from industries was aimed to identify how the collection, transport, treatment, packaging, final destination and final disposal of generated residues throughout its industrial process, identifying management actions carried out by industries in relation to residues, how is the transport carried out, if it is some treatment has been applied and how the packaging and disposal final are carried out.

The third part of the questionnaire includes questions concerning the residues management in industries, thus being able to carry out the evaluation. Through this evaluation, it was possible to verify how the questions are in the environmental sphere in industries, contemplating the final part of management.

2.4 DATA ANALYSIS

The data analysis was carried out by descriptive statistic, where realized the summation of each identify residue, obtaining the total volume and calculating the average amount generated.
This analysis consisted of organizing and tabulating the data, using Microsoft Excel and after determining the values of the data collected.

3 RESULTS AND DISCUSSION

3.1 CHARACTERIZATION OF INDUSTRIES AND THEIR PRODUCTION PROCESS

The selected industries were of two forestry segments, being 8 veneer and plywood and 4 sawmills.

The main specie used by the industries were *Pinus* spp., with 54 thousand m³/month. The *Eucalyptus* spp. was also used, but to a lesser proportion, with a 600 m³/month, followed by another wood tropical species and *Araucaria angustifolia*, with little more than 100 m³/month.

The main products generated were veneer and plywood panels. On the sawmills, the main products are the construction in general, like beams, boards, floors and walls, producing about 17 thousand m³/month of processed wood.

3.2 GENERATED RESIDUES

Throughout the production process in the veneer, plywood panels and sawmills, there is a large amount of residue, from the process and machinery, reaching levels close to 13 thousand m³/month. The main residues found in the sawmills and veneer and plywood panels industries are shown in figures 1 and 2, successively.
Through figure 1, it is possible to observe that the largest amount of waste generated corresponds to the side board, with 2505 m³/month, followed by finishing waste such as dust and shavings (2295 m³/month). The other residues found, such as sawdust and bark, generate just over a thousand m³/month.

![Figure 2. Main residues generated by the veneer and plywood panel industries.](image)

From figure 2, it is denoted that the Log core is the main type of waste generated, with 3400 m³/month. Plywood cutting is the second type of waste found in these industries, with just over a thousand m³/month generated, followed by Veneer clippings (750 m³/month). Boiler ash and hazardous waste such as glues and adhesives are also found, however, generated in small amounts. In any case, the waste generated by the logging industries need to be diagnosed in order to find means and technologies that may be used, aiming to improve management in companies and thus perform the efficient use of these waste (Mendoza et al., 2020).

In fact, the waste generated by the timber industries needs to be diagnosed, in order to find means and technologies that may be used, aiming to improve management in companies and thus carry out the efficient use of this waste (MENDOZA et al., 2020).

According to a study carried out by Louzada Junior et al. (2017), they found that the Brazilian sawmill and veneer/plywood industries generally present a 49.29% utilization rate, with waste generated from their operations corresponding to 50.71%. Barbosa et al (2014) noted that sawmills, the main representatives of the primary transformation industry, in the context of the
forest-based sector, in general, have low yields and generate a large amount of waste in their production process.

Therefore, the disposal of this waste is the responsibility of the generator, and they should be sent for recycling, having the chance to return to the market, or destined for the manufacture of handicrafts or details in the finishing of other furniture, which would avoid pollution of the environment (RECALCATTI et al. 2020). In view of this, the disposal of these wastes generated becomes an important and necessary practice, and companies must carry out the management of this material.

3.3 ASSESSMENT OF SOLID RESIDUES MANAGEMENT AND ENVIRONMENTAL PERFORMANCE OF TIMBER INDUSTRIES

Generally speaking, the Brazilian Tree Industry states that most of the waste is reused and the rest goes to the correct destination, within the legal criteria (IBÁ, 2019). On the other side, however, the present study found that only 50% of the industries separate the generated residues, most of these is sent directly to be converted into chips. Most industries carry out the packaging of the amount generated in its own installations and only one sawmill industry does not pack the material, as it allocates all of its generated material for sale.

Of the industries visited, 11 use residues generated in the industry itself and a sawmill industry disposes of the total residues generated for sale. In general, in the wood industries, due to the technology used, combined with the use of outdated equipment, there is low use of the raw material wood (BATISTA et al., 2015).

In general, this amount is managed incorrectly, as it is stored in the industrial yards or even in neighboring streets (RAMOS; RUIVO; SOUSA, 2016). It is also possible to observe, in a way, in some cases, the lack of information regarding the separation and proper disposal of waste, making this another factor for the poor management of these materials.

It is known that, when disposed of improperly, these residues can become a threat to the environment. This material, however, becomes an alternative to increase the income of the wood mechanical transformation industries. And yet, its use helps rationalize forest resources, contributing as a socioeconomic alternative to the company, in addition to helping environmentally in the management of industrial solid waste (CERQUEIRA et al., 2012). In this study, verified that almost 100% of the residues are used (11 thousand m³). The main way of use
by industries is burning for energy generation. In table above, are shown the main residues and the amount used by industries.

<table>
<thead>
<tr>
<th>Industry</th>
<th>Used residues</th>
<th>Amount (m³/mês)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sawmill</td>
<td>Sawdust</td>
<td>925</td>
</tr>
<tr>
<td></td>
<td>Dust, shavings</td>
<td>2295</td>
</tr>
<tr>
<td></td>
<td>Side board</td>
<td>2255</td>
</tr>
<tr>
<td></td>
<td>Bark</td>
<td>1035</td>
</tr>
<tr>
<td>Veneer and plywood</td>
<td>Veneer clippings</td>
<td>650</td>
</tr>
<tr>
<td></td>
<td>Plywood cutting</td>
<td>630</td>
</tr>
<tr>
<td></td>
<td>Log core</td>
<td>3300</td>
</tr>
</tbody>
</table>

Source: Authors (2023)

It was verified that the main ways to destinate the rest of the generate material, like a strait, side board, ashes, were the deposition in sanitary landfills and sale to third parties, becoming an alternative for extra income in the industry. In some regions of the country, the side board is usually used in construction, however, in the present study, it was observed that the main destination given to these is power generation.

The percentage of use verified was 61% for burning in boiler, 34% sale to third parties and 5% use in the manufacture of by-products. According to the Brazilian Tree Industry (2019), the wood processing sector designates 63.2% of its waste for energy generation through burning. Over 29.4% of industrial waste is reused as raw material by companies in the sector. Another 7.4% is divided into: lime mud, boiler ash (they are reused for cement and recycled fuel oil) and chemical compounds.

In recent years, industries have been investing in partnership programs with cooperatives and collectors, as well as process modernization technologies in order to reduce waste production. Also, in 2021, 5.02 million tons of paper shavings were collected, reaching a recycling rate of 66.7%, according to data from IBRE/FGV (IBÁ, 2022).

In industrial activity, 66.0% of waste is used to generate energy (mostly in steam boilers and eventually in the generation of electricity) and 25.5% of waste (chips, sawdust and paper shavings) is used as raw material by companies in the planted tree sector (LOUZADA JUNIOR et al., 2017).

Corroborating with the scenario seen in the present study, IBA itself brings us data regarding the use of waste these days. Waste from forest and industrial activities (peels, branches,
leaves, chips, sawdust, black liqueur), 63.6% are intended for power generation, which decreases the use of fossil fuels, and of these, 17.2% remain in the field as soil protection and fertilization. Drags and grits, silt, ash, scrap metal, plastic, cardboard, bark and sawdust (2.1%) are recycled. Sawdust, paper shavings, lime mud, boiler ash and non-hazardous waste (5.7%) are reused as raw material by the planted tree sector and other industrial sectors. Grits, dregs and mud from the process of recovery, non-hazardous waste and others (4.8%) are sent to landfills and these already specified residues have other destinations, such as processing (6.6%).

This material is generated in large quantities, therefore, the use of these waste, besides being an economic alternative to companies, contributes to the maintenance and preservation of natural resources. According to Souza et al., (2018) wood waste can return to the production process in order to add value to composites, aiming to bring economic and environmental advantages to industries, instead of improper disposal.

The use of waste should be a practice that is always present in organizations, as the impact of improper disposal of this waste on the environment affects aquatic and terrestrial ecosystems, causing important environmental impacts (OWOYEMI et al., 2016; HAJAM et al., 2020).

Any form of waste reuse encourages the opening of a new production cycle that can serve the existing market or create new demands, reducing the amount of unused waste (COSTA et al., 2020). For example, Akutagawa et al. (2020) undertook feasibility studies on the use of saw dust by adding wheat straw to produce panels from the combination of these residues, having obtained satisfactory preliminary results. Garcez et al. (2018) found that wood industry residues have the potential to be used in the production of lightweight masonry components, presenting them as an alternative to other materials.

As verified by da Silva Júnior et al. (2019), some forms of waste utilization have already been studied over the years by some authors, such as: steam generation (SCHNEIDER, 2003); production of small wooden objects (LIMA, 2005); manufacture of briquettes (PIRES et al., 2007); energy sources and extraction of essential oils (NOLASCO et al., 2014).

In this research, according to table 2 below, 9 industries have different integrated environmental management systems and only 3 have no implemented any program. Among the verified systems, it stands out for the reverse policy of solid waste, control of gas emission, particulate emission control, closed circuit of water, 3S system, IAP reports and operating licenses.
Table 1. Environmental scenario of the industries studied.

<table>
<thead>
<tr>
<th>Environmental management system</th>
<th>Raw material certification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holds</td>
<td>Does not hold</td>
</tr>
<tr>
<td>Solid waste reverse policy</td>
<td>FSC</td>
</tr>
<tr>
<td>Gas emission control</td>
<td>C2+ (species)</td>
</tr>
<tr>
<td>Particulate emission control</td>
<td>BC (species)</td>
</tr>
<tr>
<td>Closed water circuit</td>
<td>CDX (species)</td>
</tr>
<tr>
<td>3s system</td>
<td>DOF (species)</td>
</tr>
<tr>
<td>Formaldehyde emission control</td>
<td></td>
</tr>
<tr>
<td>IAP annual reports</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>3</td>
</tr>
</tbody>
</table>

Source: Authors (2023)

Companies could have a management plan for these resources, which would help reduce environmental impacts and generate income for owners (COSTA et al., 2020).

Solid waste management plans, an instrument of the National Solid Waste Policy (PNRS), are designed to guide the management of solid waste produced in companies, and must consider the following order of priority: non-generation, reduction, reuse, recycling, solid waste treatment and environmentally appropriate final disposal of waste (BRASIL, 2010).

Regarding the certification of the raw material used, only five industries of a total 12 had some type of raw material certification among these only one sawmill and 4 veneer and plywood industries, like an FSC, C2+ (species), BC (species), CDX (species). The companies with certification also had integrated management systems. This is because most industries direct its products to the domestic market and in this case, at national levels, the certification requirements are lower.

4 CONCLUSION

It can be concluded that the timber industries generate a large amount of waste, which, in general, lack alternatives aimed at the best choice of destination and use. It is also observed that, in some cases, the lack of information regarding the packaging, treatment and final disposal of waste is scarce, which contributes to the mismanagement of this material.

The type of waste with the highest amount diagnosed was the "log core" type, with 3400 m³/month generated, coming from the eight plywood industries. This type of material presents potential for reuse, not only as a source of energy, as is already done by some industries, but also as raw material for other products.

The other types of waste were “side board” (2100 m³/month) and “wood processing finishing residues” (2500 m³/month), from sawmills, “bark” and “sawdust” (1200 to 1300...
m³/month). These materials are generated in large quantities and, normally, accumulate in large volumes in industrial yards, improperly arranged and liable to cause environmental damage to the ecosystem and the surrounding population.

The “plywood cutting” (1202 m³/month) and the “veneer clippings” (750 m³/month) were also found in the diagnosis, representing an important value generated, in which they have potential, as well as the “log core”, to be reintegrated into the production process as part of other products. Boiler ash, glue and adhesive residues appeared in smaller quantities.

It should be noted that the diagnosis of waste generation in the timber industries is an important tool, as it allows knowing the amount generated as well as the types of waste generated, contributing to better management and final destination of this material, without being disposed of inappropriately, causing environmental damage.
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